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Aug. 8. This is a plant of high northern distribution, appearing also in the Alps. The identification of my specimen rests upon its perfect agreement with one from northern Norway collected by Hagen, without the help of which it would probably have remained undetermined. As the fruit of this species is as yet unknown, its generic affinities are perhaps not absolutely certain. *Didymodon* is at best an artificial genus.

6. *Tortula subulata* (L.) Hedw. On rocks at Seydhisfjörður, July 8; on the lava-field by Hafnarfjörður, July 23; on rocks by the waterfall Tröllafoss near Reykjavík, July 28. This species must be common and it is probably due merely to an oversight that Grönlund omitted it from his revised list of 1881 after having included it in his preliminary one of 1873.

7. *Pohlia polymorpha* Hornsch. On lava-field by Hafnarfjörður, July 23; on slope of Lágafell near Reykjavík, Aug. 4. This species was fully to be expected and is doubtless not uncommon.

ITHACA, N. Y.

## REVIEWS

### Clements's Plant Succession \*

An important stage in the development of ecology is marked by the appearance of Doctor Clements's Plant Succession. This large and comprehensive work is the first systematic monograph on the series of complex phenomena in the development of vegetation called succession. It contains in addition to the author's own investigations a full account of the literature not only of the United States but of the entire world.

Just as many students of modern ecology have found Research Methods in Ecology (1905) so helpful in solving problems in a quantitative manner, likewise the rapidly growing ranks of synecologists may well turn to Plant Succession for a clear statement of the development of the subject, its present status, and its future outlook. Clements's work in the field for 20

\* Plant Succession, an analysis of the development of vegetation. Frederic E. Clements, professor of botany in the University of Minnesota. Carnegie Institution of Washington, 1916, pp. i-xiii + 1-512, with 61 photographic plates and 51 figures in the text.

consecutive summers, together with his extensive opportunities of studying North American vegetation on a large scale for a period of 15 months in 1913-1915, during which time he made numerous journeys throughout the western half of the continent from the Great Plains to the Pacific coast and from the Canadian Rockies to the Mexican boundary, testing principles and processes of vegetational development, eminently fit him to evaluate and correlate the results of investigations in restricted areas.

The very complete set of abstracts of publications dealing with succession from the time of the earliest investigation (King, 1685) to the present (Chapter II); together with an historical summary of the units of vegetation (Chapter VII), a concise statement of the several views on the "Direction of Development" (Chapter VIII), and the various systems of classification (Chapter IX) in which the careful and full discussion of the views of such authors as Cowles, Cajander, and Moss are given, is a very valuable feature of the book, affording the student the necessary perspective for an understanding of the present status of the subject.

The principle, stated in 1904,\* that the plant formation is a complex organism with a characteristic development and structure, is here elaborated and developed, forming the fundamental thesis. The formation is put entirely upon a developmental basis. "As an organism, the formation arises, grows, matures, and dies. Its response to the habitat is shown in processes or functions and in structures which are the record as well as the result of these functions. Furthermore, each climax formation is able to reproduce itself, repeating with essential fidelity the stages of its development. The life-history of a formation is a complex but definite process, comparable in its chief features with the life of an individual plant. The climax formation is the adult organism, the fully developed community, of which all initial and medial stages are but stages of development. Succession is the process of the reproduction of a formation, and this reproductive process can no more fail to terminate in the adult form in vegetation than it can in the case of the individual plant."

\* Clements, F. E., *Development and Structure of Vegetation*, Rep. Bot. Surv. Nebr. 7.

"The formation is the unit of vegetation. It is the climax community of a natural area in which the essential climatic relations are similar or identical." It is an organic entity covering a definite area marked by a climatic climax. It consists of associations which are actual parts of the area with distinct spatial relations. The author distinguishes in North America ten forest climaxes or formations, six scrub formations, a prairie-plains climax and the tundra formation.

The subordinate vegetational units are either climax or developmental; the relation of these units to the formation, the relation of the units of each series to each other and the correspondence of the units in the two series is shown in the following table.

| FORMATION         |              |
|-------------------|--------------|
| Climax Units:     | Seral Units: |
| Association.....  | Associates   |
| Consociation..... | Consociates  |
| Society.....      | Societies    |
| Clan.....         | Colony       |
|                   | Family       |

The need of a set of units to distinguish seral from climax phases of vegetation is felt by ecologists who are interested in the study of the development of vegetation, while to others, as the author points out, this may seem an unnecessary refinement. That the system of vegetation outlined is not only logically complete but that it corresponds well with actual phenomena of vegetation is shown in addition to the author's own illustrations by its application to vegetation in Minnesota by Bergman & Stallard\* and to three plant formations in the Pacific Northwest by the reviewer.†

The term association is restricted "to those climax communities which are associated regionally to constitute the formation." Associations agree with their formation in physiognomy and development, and are recognized chiefly by floristic differences. Thus the prairie-plains formation consists of three associations;

\* Bergman, H. and Stallard, H., *Plant Succession in Northern Minnesota, Minnesota Botanical Studies*, Vol. 4, No. 4, 1916.

† Weaver, J. E., *Ecological Studies in Southeastern Washington and Adjacent Idaho, Univ. Nebr. Studies* 17: 1, Jan. 1917.

the *Stipa-Agropyron* prairie, the *Bulbilis-Bouteloua* plains, and the *Aristida-Bouteloua* desert plains.

"The consociation is the unit of the association. It is characterized by a single dominant. The association is actually a grouping, the consociation is pure dominance." In the usual treatment most consociations appear as associations. In the *Aristida-Bouteloua* association, for example, the dominance of *Aristida* gives rise to an *Aristida* consociation.

Turning now to the seral units, "the associes is the developmental equivalent of the association." "It is composed of two or more consocieties, *i. e.*, developmental consociations, just as the association consists of two or more consociations. Like the association it is based upon life-form, floristic composition, and habitat, but differs from it in as much as all of these are undergoing constant or recurrent developmental changes." While the association is permanent, in so far as development is concerned, the associes is transient, although it may persist for many years. Thus *Pinus-Pseudotsuga* and *Larix-Abies* form associes in Idaho which are developing towards the *Thuja* consociation of the Pacific coast forest formation. Now where *Pseudotsuga* dominates over an area we have a *Pseudotsuga* consocieties, for a "consocieties is a seral community marked by the striking or complete dominance of one species, belonging of course to the life-form typical of that stage of development." It differs from the consociation only in that it is a developmental or seral, while the latter is a climax community.

Whether the investigator is dealing with climax or developmental units can be determined only by the application of such exact quantitative methods as are outlined under "the investigation of succession" (Chapter XV). An application of such methods will go a long way towards solving the problems of vegetational development of a region—a phase of ecology which American investigators have recently shown to have a fundamental bearing upon forestry, grazing and agriculture.

The concept of succession as a series of invasions, a sequence of plant communities marked by the change from lower to higher life-forms is analyzed at length. "The essence of succession lies

in the interaction of three factors, namely, habitat, life-forms, and species, in the progressive development of a formation. In this development, habitat and population act and react upon each other, alternating as cause and effect until a state of equilibrium is reached." "Succession can be studied properly only by tracing the rise and fall of each stage, and not by a floristic picture of the population at the crest of each invasion." The causative processes of succession are distinguished as initiating or initial, continuing or ecesic, and stabilizing or climatic. Initial causes—the getting ready of the field for action—are grouped under topographic, climatic and biotic. Under ecesic causes the phenomena of aggregation, migration, ecesis, competition and invasion are fully developed.

In Chapter V (Reactions) the writer points out how the reactions upon the habitat of communities of initial and medial stages are such as to produce conditions unfavorable to themselves or at least favorable for new invaders which succeed gradually in the course of competition or become dominant and produce a new reaction unfavorable to the pioneers. Ultimately, however, a time comes when reactions are more favorable to occupants than to invaders, and the existing community becomes permanent, constituting a climax. The climax vegetation is complete dominance, its reactions being such as to exclude all other species. The result of progressive invasion is stabilization. "It is the mutual and progressive interaction of habitat and community, by which extreme conditions yield to a climatic optimum and life-forms with the least requirements are replaced by those which make the greatest demands, at least in the aggregate."

"The recognition of development as the cause and explanation of all existing climax formations forced the conclusion that all vegetation has been developmentally related" and led the author to "the further assumption that the processes or functions of vegetation today must have been essentially those of the geological past, and that the successional principles and processes seen in existing seres hold equally well for the analysis of each eosere."

Past climates and climaxes are fully discussed (Chapter XII) under the captions of botanic and zoöic evidences, causes of climatic changes, climatic cycles and finally the correlation of climatic cycles and succession. The succession of plant populations in the various geological areas and periods forms the topic for three additional chapters.

The large number of well-chosen and excellent photographs add materially to the value of the book, which no working ecologist can afford to be without.

J. E. WEAVER

UNIVERSITY OF NEBRASKA

**Grout's Moss Flora of New York City and Vicinity\***

The study of the local flora of New York City and vicinity has been one of the main activities of the Torrey Botanical Club since its foundation and its members will welcome the appearance of Dr. Grout's attractive booklet on the moss flora of their region. Following so soon the publication of Taylor's "Flora of the Vicinity of New York," which was limited to the spermatophytes and pteridophytes, it will not only stimulate the study of the group of plants with which it is directly concerned, but will also encourage the publication of other special local floras covering the Hepaticae, fungi, algae, etc., of the region of New York City. Dr. Grout's moss flora includes descriptions of the families and genera, keys to the families, genera, and species, notes on the habitat and known distribution of the species, and very successful habit photographs of nineteen of the more characteristic or interesting mosses of the local field.

M. A. HOWE

NEWS ITEMS

The Board of Governors of the International Garden Club has authorized the publication of a *Journal* devoted to gardening and horticulture. The pages of the new *Journal* will be open to members and others, and it is expected to issue the first number as soon as possible. The Board appointed Norman

\* Grout, A. J., *The Moss Flora of New York City and Vicinity*. 8vo, pp. 1-119. *pl.* 1-12. 1916. Published by the author, New Dorp, N. Y.